ITW Paktron
FILM CAPACITORS

AN INTEGRAL PART OF
TOMORROW'S TECHNOLOGY

Exclusive Agent
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QUENCHARC®
CAPACITOR

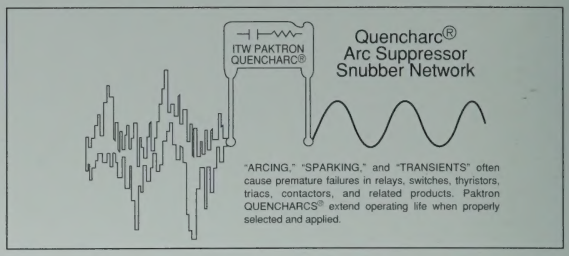
NOISE & ARC SUPPRESSION SNUBBER NETWORK

- Relay contact protection
- Noise reduction on controllers/drivers
- dv/dt suppression on thyristor and triacs.
- EMI/RFI reduction
- No lag time in suppression
- Available voltages: 125 VAC - 660 VAC

QUENCHARC®
Suppressor Type Q

QUENCHARC®
R-C Network Type QRL

UL Recognized For Across-the-Line


ITW PAKTRON QUENCHARC®
Quencharc® Arc Suppressor Snubber Network
"ARCING," "SPARKING," and "TRANSIENTS" often cause premature failures in relays, switches, thyristors, triacs, contactors, and related products. Paktron QUENCHARCS® extend operating life when properly selected and applied.

Tolerance: Capacitor ± 20%, Resistor ± 10%.

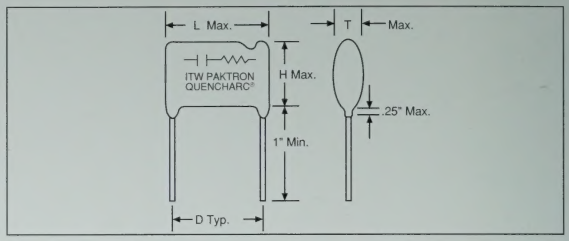
Construction: Metalized polyester capacitor in series with a carbon composition resistor.

Case: Coated with a flame retardant epoxy.

Wire Leads: #20 AWG (.032") capacitor end. #18 AWG (.040") for QH & QV styles. Resistor end .025" to 0.045".

Marking: ITW, Quencharc®, capacitance, resistance, voltage.

Performance Data: See page 3.



HOW TO ORDER

QA QB QC QD QE QH QT QV

EXAMPLE: .1 MFD ± 20% 600 VDC 100 Ohms =

104	M	06	QC		100	
PF CODE	**TOLERANCE**	**VOLTAGE**	**TYPE**		**RESISTOR**	
	M = ± 20%	P5 = 50 VDC	QA	QD	3.9	150
		02 = 200 VDC/125 VAC	QB	QE	10	220
		06 = 600 VDC/250 VAC	QC	QT	22	330
		48 = 1200 VDC/480 VAC	QH	QV	39	470
		66 = 1600 VDC/660 VAC			47	680

HOW TO ORDER

QRL

EXAMPLE: .1 MFD ± 20% 125 VAC 150 Ohms =

104	M	AC	QRL	150	
PF CODE	**TOLERANCE**	**VOLTAGE**	**TYPE**	**RESISTOR**	
104	M = ± 20%	AC = 125 VAC	QRL	150	470
				220	680
				330	

Type QRL: UL Recognized for 125 VAC across-the-line. UL File No. E33628.

PF CODE	MFD ± 20%	VOLTAGE	TYPE	OHMS ±10%	WATT	T	H	L	D
104	.1	50 VDC	QT	3.9 to 100	1/2	.27	.62	.55	.40
104	.1	600 VDC/250 VAC	QC	22 to 680	1/2	.39	.66	1.08	.82
104	.1	1200 VDC/480VAC	QH	39	2	.64	1.04	1.60	1.29
104	.1	1600 VDC/660VAC	QV	39	2	.54	1.00	2.18	1.80
254	.25	600 VDC/250 VAC	QD	22 to 680	1/2	.42	.75	1.45	1.20
504	.5	600 VDC/250 VAC	QE	22 to 150	1/2	.59	.92	1.45	1.20
504	.5	600 VDC/250 VAC	QE	220 to 330	1	.59	.92	1.54	1.25
504	.5	600 VDC/250 VAC	QE	470 to 680	2	.59	1.00	1.63	1.29
504	.5	200 VDC/125 VAC	QA	22 to 680	1/2	.37	.64	1.08	.82
105	1.0	200 VDC/125 VAC	QB	22 to 330	1/2	.39	.66	1.45	1.20
105	1.0	200 VDC/125 VAC	QB	470 to 680	2	.43	1.00	1.63	1.29
UL Recognized Across-the-Line Application				NOTE: Type QRL will meet the requirements of UL1414.					
104	.1	125 VAC	QRL	150 to 680	1/2	.44	.66	1.08	.82

ITW Paktron
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HOW THE QUENCHARC® WORKS

QUENCHARC® PERFORMANCE CHARACTERISTICS (TYPICAL)

OPERATING TEMPERATURE RANGE

–55°C to +85°C at full rated voltage.

DISSIPATION FACTOR

The nominal dissipation factor is determined from the following equation:

$DF = 2\pi fCR + .006$

where:

f = test frequency in hertz

C = nominal capacitance value in farads

R = nominal value of series resistor in ohms.

DIELECTRIC WITHSTANDING VOLTAGE

Unit shall withstand a DC potential of 1.6 times the DC voltage rating. Testing conducted at 25°C.

DC LIFE TEST

Unit shall withstand a test potential of 125% of the rated voltage for a period of 500 hours at a temperature of 85°C. A failure shall consist of:

- Capacitance change greater than 5%.
- Dissipation factor greater than original limits.

LONG TERM STABILITY

The capacitance shall not change more than 2% when stored at ambient temperature and humidity for a period of 2 years or less.

The most popular and commonly used method of arc suppression is to connect a resistor-capacitor network as shown in Figures A and B. The preferred method of connection is across the contacts it wants to protect. However, the network can be hooked across the load, as is shown by the dashed line, when all inductance of the load circuit is considered lumped together.

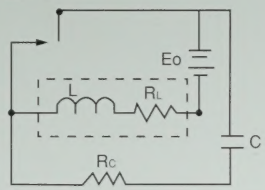


Figure A

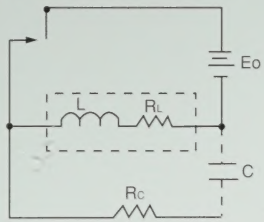


Figure B

When the contacts open, the voltage across the uncharged capacitor is zero and the transient voltage starts charging the capacitor. In the meantime, the gap of the contact is steadily widened, and by the time the capacitor is charged to its full potential, the contact gap is widened well beyond the minimum breakdown potential of air, thus preventing the arcing. When the contact closes, the inrush current from the capacitor may damage the contact, and here resistance is needed to limit the maximum current to Eo/Rc during the contact closure.

The induced voltage on opening the contact is

$$V = IR_C = \frac{R_C}{R_L} E_o \qquad (1)$$

and, as can be seen, the larger the value of a series resistor, the higher the induced voltage. On the other hand, the lower series resistance makes the current on contact closure higher. The time dependence of the voltage is given by:

$$V(t) = L\frac{di}{dt} + (R_L + R_C)i + E_o + \frac{1}{C}\int_o^t i\,dt \qquad (2)$$

and the rate of voltage change, which is important in transient suppression of triac switching, is:

$$\frac{dv}{dt} = L\frac{d^2i}{dt^2} + (R_L + R_C)\frac{di}{dt} + \frac{i}{C} \qquad (3)$$

Equation (3) tells us that by knowing the circuit conditions with given values of L and coil resistance that limit the current prior to contact opening, the rate of voltage rise is inversely proportional to capacitance. In other words, the larger the capacitance, the greater is the transient suppression. However, when the contact closes, the additional energy stored in the capacitor has to be discharged through the contact. Hence, a compromise has to be made in the selection of both resistance and capacitance.

In an effort to provide a simple answer to designers' requests for proper values of resistance and capacitance, some relay manufacturers came out with empirical formulas and nomographs. For instance, C.C. Bates[1] gives

$$C = \frac{I^2}{10} \qquad R = \frac{E_o}{10I\left(1+\frac{50}{E_o}\right)}$$

the equations

where C = capacitance in MFD

I = load current in amperes prior to contact opening

R = resistance in ohms in series with capacitor

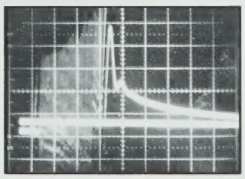
E_o = source voltage

The choice of resistance and capacitance value however, is quite flexible. In fact, the choice is so simple that one does not need a nomograph at all. Besides, a nomograph published by a certain relay manufacturer may be for the particular relays the firm manufactures, not necessarily universal.

[1]Bates, C.C., "Contact Protection of Electromagnetic Relays." *Electromechanical Design*, August, 1966.

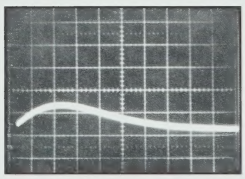
Voltage Waveform

UNSUPPRESSED



100V/div .1ms/div

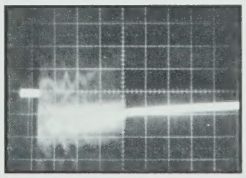
SUPPRESSED



100V/div .5ms/div

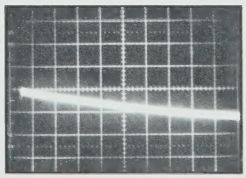
Current Waveform

UNSUPPRESSED



100mA/div .1ms/div

SUPPRESSED



50mA/div .1ms/div

TWPaktron

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CHOOSING A QUENCHARC®

In choosing a Quencharc®, first of all, check the maximum switching current rating of the contacts to be protected. This value differs for different types of contact materials and different types of relays. The maximum current during the contact closure with an RC network is E_o/R_c, where E_o is the source voltage and R_c is the resistance value of the network. The quantity E_o/R_c must be lower than the maximum switching current for obvious reasons. Next, the selection of capacitance is best done with an oscilloscope.

Connect the oscilloscope probe to the relay wiper and ground the other plate of the contact. Without an RC network across the contacts, check the amplitude of the transient voltage on contact break and the amplitude of the current on contact make. If the voltage is less than 300V and the current less than the maximum switching current rating of the relay, and if you don't see any arcing, you may not need the contact protection at all. If you spot arcing, connect a .1 mfd + 100 ohm, 250 VAC, QC100 (our most widely used Quencharc®), across the contacts, and observe the levels of suppression, voltage on break and current on make. The suppressed voltage should be below 250V, which provides 70 volts of safety margin from the breakdown potential of air. If the voltage is still above 250V, try a .25 mfd + 220 ohms or a .5 mfd + 330 ohms range. If you need a higher capacitance than 1.0 mfd, you may be better off with a Zener or a varistor in terms of cost and space. For most relays and triacs .1 mfd + 100 ohms provides a satisfactory suppression.

When protecting contacts in AC circuits, the same general guidelines as for DC circuits can be used, but the wattage of the resistor must be considered if current flow is sustained for a long enough period of time to heat the component. Compute the impedance of the RC unit to obtain a current value, then use I^2R and time considerations to determine whether the standard network resistor is adequate.

Bear in mind a matter of supreme importance: in the interest of economy and minimum contact erosion, the capacitance value should be no larger than is necessary to insure reliable contact opening essentially without arcing. Excessive suppression must be avoided in order to least interfere with the mechanical movement of the relay as originally intended. For instance, anxious to suppress transient voltage and current as much as possible, suppose one chose an RC with high capacitance and high resistance. The time constant RC then would be fairly large, and if the load inductance is due to another relay, the release time for the load relay will be greatly affected, not a good practice for the life of the relay. Typical release times of different arc suppression devices is given in the following information:

Comparison of Effects of Various Arc-inhibiting Circuits[2]

Results for a 28-volt d-c, 6-pole, hermetically sealed relay

	Peak induced voltage	Release time (ms)
Unsuppressed	950	1.5
Capacitor, 0.22 MFD	120	1.55
Zener diode, 60 volts	190	1.7
Diode and 470-ohm resistor	80	5.4
Varistor (Globar 432BNR-35)	64	2.7

For further information, the minimum arcing current I_a, the minimum contact welding current I_w, and the minimum arcing voltage E_a for the most commonly used contact materials are given in the following table:

Limiting Arcing and Welding Currents and Arcing Voltages for Some Contact Materials[3]

Materials	I_a (amperes)	I_w (amperes)	E_a (volts)
Silver	0.4	19.0	12.0
Gold	0.4	11.0	15.0
Gold alloy (69% gold, 25% silver, 6% platinum)	0.4	11.0	9.0
Palladium	0.8-1.0	16.0	
Tungsten	1.0-1.4		16.5

Note: Values apply to contacts that are not activated by organic vapors.

Finally, to answer the question to which there is no answer,"Which method is the best of all for arc suppression?" The answer is *the one that interferes the least with the laws of nature.*

The very existence of arcs attests to it; given the circuit arrangement and switching characteristics, the arc *must* occur in obedience to natural laws. That is why excessive transient suppression is not only undesirable but in many cases harmful. A shunt diode may suppress the transient marvelously but the effect of its longer release time on the structural durability of the relay must be carefully explored. A resistor may be simple to install but what the power drain does to the rest of the circuit must be investigated. A contact protection network must not be judged by what it does to the contacts alone but by the over-all performance of circuit.

In this sense, a Quencharc® is superior to other devices. The principle involved is to provide a mechanism for energy transfer rather than a means for energy dissipation.

Let us emphasize one more thing. A device must perform the intended function first. Then it must be reliable, and to check this out, some kind of long-run performance test should be conducted to make sure that the contact protection network is *compatible* with the rest of the circuit. And then comes the cost, configuration, color, or what you like. Theories may be fascinating, but nothing is more comfortable than good experimental results.

[2]National Association of Relay Manufacturers, *Engineers Relay Handbook*, New York: Hayden Book Co., 1947.
[3]*Ibid.*

IMPORTANT NOTICE TO PURCHASERS AND USERS

All statements, technical information and recommendations are based on tests we believe to be reliable, but their accuracy or completeness is not guaranteed.

Buyer shall determine the suitability of the product for the intended use and Buyer and User assume all risk and liability of every kind. Any other statement or recommendation shall not be binding or have any force unless in a separate written agreement signed by officers of Seller and Manufacturer.

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